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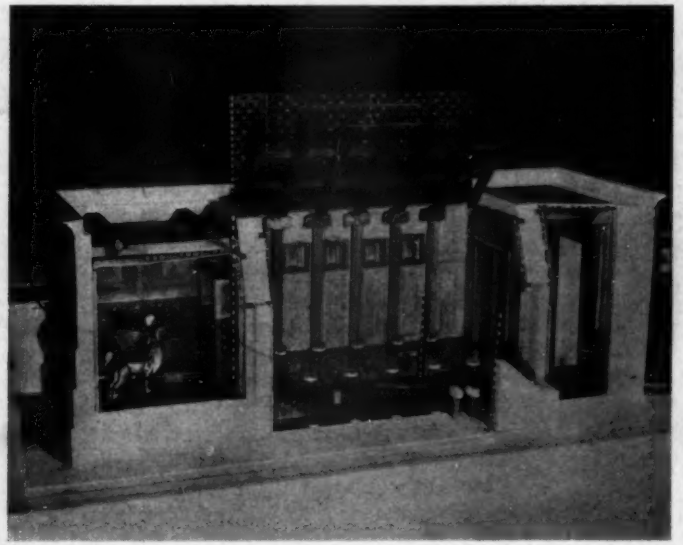

Fig. 1. The Howland-Garber model of Solomon's Temple. The Side Chambers are here removed and the roof pallet raised so that the interior can be seen. (Unless otherwise noted, photographs used in this issue are copyright by E. G. Howland and used with his permission.)

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RECONSTRUCTING SOLOMON'S TEMPLE

Paul Leslie Garber

Agnes Scott College, Decatur, Georgia

The Jerusalem Temple which Hiram of Tyre designed and constructed was "by far the most famous of the architectural wonders of Solomon."[1] It was also the Bible's most celebrated building. References to the temple of Solomon, to that which preceded it as the Israelite cultic center (the Mosaic Tabernacle) and to the attempted reproductions of its glory (the temples of Zerubbabel and Herod) appear at least once in 23 of the 39 Old Testament books and in 11 of the 27 New Testament books.

Professor Wright's question, "What was it like?"[2] represents a valid concern for our day as it was for biblical writers. Jeremiah 52 and Ezekiel 40-42 are contemporary witnesses to prophetic interest. II Chronicles 3-4 and its earlier, more reliable parallel in I Kings 6-8, with their detailed descriptions of the Temple's floor plan, construction, decoration and furnishings indicate that both priestly and prophetic historians considered these subjects worthy of minute consideration.[3]

The Talmud, Josephus and the church fathers add little to biblical data on the appearance of the Temple. Interpretation of the Temple passages by visual representations (artists' reconstructions, floor plans, drawings or models) seems not to have concerned European students of the Bible prior to the 18th century.[4] During the 19th century the Solomonic temple attracted the interest of the scholarly world in a curious manner. The titles of more than thirty different books on this subject are known to have been published in the last century, works in German, Italian, French, Latin and English. The discoveries of biblical archaeology have been available in the main only to students of Solomon's Temple in the present century. It is this new-found body of information "which now enables us to examine older reconstructions and say: 'The Temple certainly could not have looked like those!' "[5]

Readers of this journal have been made aware from its first number of the aid biblical archaeology offers to those who would understand

accurately the Solomonic period of Israel's history. A summary of this material as it bears on the Temple was made in the editor's article, "Solomon's Temple Resurrected."[6] He intimated that such data now made possible a reconstruction of the Temple which would rest more soundly on facts than any yet produced.

Mr. E. G. Howland, a professional model maker of Troy, Ohio, and I have combined forces in an effort which has extended over the past four and a half years to meet the challenge offered by Dr. Wright. Our purpose was to produce an accurate scale model of Solomon's Temple (¾ of an inch to the cubit) which would incorporate the latest findings of textual study and the relevant data from biblical archaeology, the feasibility of each suggestion being tested in actual construction. We

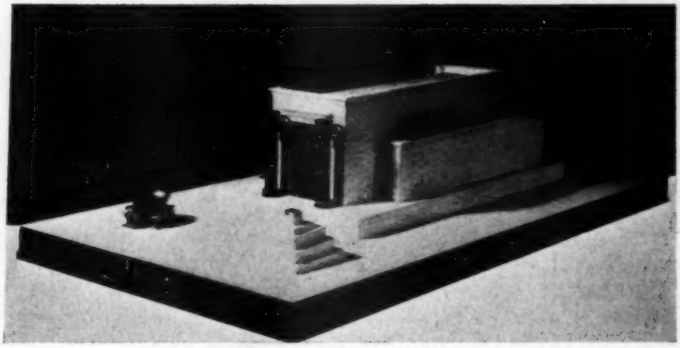

Fig. 2. The Howland-Garber model of the Temple of Solomon as it appeared at its first public showing at Agnes Scott College, Decatur, Georgia, Oct. 17, 1950. In the finished model a portion of the left side is cut away so that the interior can be seen.

wanted a representation of the Temple which school teachers of church and synagogue, as well as college and university professors, could use with confidence. Mr. Howland has supplied at his own cost his skills as a craftsman, his time and the materials of the model as a generous gift toward the advancement of scholarly biblical study. My part has been to do the research necessary to supply reliable answers to the problems raised during the course of construction. We refused to put into the model any feature for which we were unable to secure authorization from the work of some recognized scholar. This policy resulted in our

1. Wright, G. E., "Solomon's Temple Resurrected." B. A., IV. 2 (May 1941).
2. Ibid.
3. Characteristics of the King's record revealed during the construction of the Howland-Garber model, I hope to discuss in some later publication.
4. Cf. Bh. Lamy published in Paris, 1720, and O. Altshule in Amsterdam, 1724. For early bibliography see Hastings DB art. "Temple" by T. W. Davies.
5. Wright, G. E., op. cit.
6. Ibid.

omitting from the model many features usually thought to be parts of the Temple, for example, the towers flanking the Porch, the exterior side doors and the cubical-like arrangement of the Side Chambers. Mr. Howland and I will be satisfied if others find the model to warrant Professor Albright's estimate: "It is certainly a much closer approach to the original Solomonic Temple than any model or drawing yet made."[7]

THE TEMPLE COURT

The "inner court of the house of the Lord" (I Kings 7:12) may refer to the paved level area set apart for the Temple.[8] If so, that court was marked off by a low "fence" of "three rows (courses) of hewed stones and a row (course) of cedar beams." Whatever else there may have been, our sources are inadequate for us to know. Presumably some sort of housing for priests was provided and there were probably other structures used in the Temple business.

The Court contained, according to Kings, the Molten (Brazen) Sea and ten smaller wheeled lavers.[9] Chronicles adds a feature described in greater detail in Ezekiel 43, the Altar of Burnt Offering.

Biblical "brass" in the age of Solomon, as Dr. Glueck has made evident by his discoveries at Ezion-geber,[10] was a poorly refined alloy of copper. Solomon held what may have amounted to a Palestinian monopoly on this metal in his day. He could have afforded to supply Hiram of Tyre with the considerable quantity of it needed for as impressive an accomplishment in metal-working as the Sea. This hemispherical bowl, 15 ft. in diameter and 7½ ft. high, was a casting about 3 inches thick. Its brim was "wrought like the brim of a cup, like the flower of a lily" (I Kings 7:23). It held two thousand "baths" (almost 10,000 gallons, or about 317½ barrels).[11] The weight of the Sea has been estimated to have been between 25 and 30 tons. This entire load could scarcely have been supported solely on the slender legs of the twelve cast bulls which appeared to uphold the Sea; some sort of center support must be supposed. King Ahaz replaced these bulls with stone supports when he "took" the bulls "for the King of Assyria" (II Kings 16:17-18).

The twelve calves were arranged in four groups of three, each trio headed toward the major points of the compass. The arrangement symbolized, according to Professor Albright, "the round of the seasons through the year."[12]

The Temple descriptions in II Chronicles 3 and in Ezekiel 43: 13-17 give prominent place in describing the Court to a burnished copper Altar of Burnt Offering of impressive proportions. Dr. Albright considers the omission of this feature in I Kings to be "due to accident" and without religious reasons.[13] He thinks this altar was built in stages like a Babylonian temple-tower, the uppermost stage being crowned with "horns." Archaeological discoveries are yet to be made which would supply the details of design and decoration which would make possible

a complete reconstruction of the Altar of Burnt Offering.[14] The Howland-Garber model of the Altar is intended to block out in rough outline only what is definitely known of this feature.

Dr. Albright convincingly translates Ezekiel 43:14 as naming the top level of the great Burnt Offering Altar "mountain of God," *(har'el)* and thus interprets the Altar as symbolizing the mountains of the created universe.[15] If so, then the copper-bowl Sea could have stood for the subterranean fresh water ocean from which the ancients believed all life and fertility were derived.[16]

THE TEMPLE EXTERIOR

King Solomon was, in Dr. Wright's phrase, "something new" in Israelite kingship – he was a "commercial tycoon."[17] He was engaged as middle-man in trading Cilician horses and Egyptian chariots. He put to use the recently domesticated camel as a "ship of the desert" for long hauls.[18] He was, as Dr. Glueck has made clear, in addition to all this

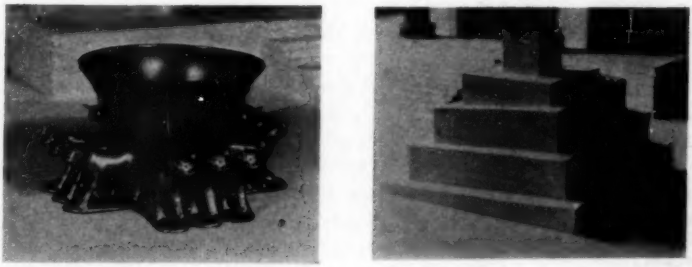

Fig. 3. On the left is the copper "Sea" with its "lily" cup-brim. The original was a huge affair, holding some 10,000 gals. of water, presumably for use in the sacrificial service. On the left is a reconstruction of the Altar of Burnt Offering, according to Ezekiel. (The little copper pan here seen resting on the Altar's "horns" has no ancient analogy and probably should not be there. —G. E. W.)

a copper and iron magnate.[19] The peaceful state of world affairs combined with Solomon's ingenuity in making his services valuable to his

7. Letter to the writer, October 9, 1950.
8. Gottstein's model in the New York Jewish Museum diorama "Proclaim Freedom" (1950) shows no paved court, no altar and no sea.
9. The smaller wheeled lavers we have not reproduced. The type is illustrated by a Cyprus finding (Gressmann, H., **Altorientalische Texte und Bilder zum A. T.**) which bears close resemblance in size and description to the record in 1 Kings 7:27-39.
10. Glueck, Nelson, **The Other Side of the Jordan** (1940) pp. 92ff.; **Bulletin of the American Schools . . .** 79, pp. 3f.; **BASOR** 90, pp. 13f.
11. Wylie, C. C., "On King Solomon's Molten Sea," B. A., XII, 4 (December 1949), p. 86.
12. Albright, W. F., **Archaeology and the Religion of Israel**, pp. 149-150. Cf. Psalm 19:6.
13. **Ibid.**, pp. 151-152.
14. McCown, C. C., "Hebrew High Places and Cult Remains," **Journal of Biblical Literature**, LXIX (1950), pp. 250-220.
15. Albright, W. F., **op. cit.**, pp. 149-150.
16. Wright, G. E., **B. A.**, VII, 2 (December 1944), p. 74. For the older views, see Benzinger in **The Encyclopedia Biblica**, col. 4341.
17. Wright, G. E., **B. A.**, IV, 1 (May 1941), p. 17.
18. Albright, W. F., in **The Jews**, edited by L. Finkelstein (New York, 1950), p. 27. Isserlin, B. S. J., **Palestine Exploration Quarterly** (Jan.-Apr. 1950), pp. 50-53
19. Glueck, Nelson, "The Excavations of Solomon's Seaport: Ezion-geber," **The Smithsonian Report for 1941** (Washington D. C., 1941) pp. 453-478.

more illustrious monarch-neighbors served to produce a period of economic inflation in the land of Israel which was to be long remembered with nostalgia. "And the king made silver to be in Jerusalem as stones . . . for abundance" (I Kings 10:27).

The Temple Solomon built was a part of all this. It was not as large as some in the ancient world, nor was it as ornate. It stood, however, for nearly four hundred years as one of the wonders of the biblical world renowned for its dignified simplicity and the excellence of its craftsmanship.[20] A "jewel-like structure," someone has called it. "And when the queen of Sheba had seen . . . the house he had built . . . there was no more spirit in her" (I Kings 10:4-5).

FLOOR PLAN

The Temple was essentially a house of two rooms arranged lengthwise. The entrance, which may have faced East,[21] was on the short side and an open Porch *(Ulam)* sheltered the single door. The larger room, called the Holy Place *(Hekal)*, was 60 ft. long, 30 ft. wide and 45 ft. high. The inner room, called the Holy of Holies *(Debir)*, was a cube 30 ft. by 30 ft. by 30 ft.; this size was made possible by a raised floor (cf. the raised sanctuary of the Tell Tainat chapel). These two rooms had counterparts in the two divisions of the Tabernacle (Ex. 25-31, 35-40). Furthermore, it appears from the small 8th century chapel discovered by the Oriental Institute at Tell Tainat (ancient Hattina) that the Porch *(Ulam)* was "the style" with Phoenician builders. Hiram, Solomon's most prominent artisan, and thus presumably architect of the Temple as well as its contractor, was of Hebrew extraction but was from Tyre and had learned his art from the Phoenicians (I Kings 7:13, 14).

The Side Chambers are spoken of in Kings as a non-essential feature built "against the walls of the house round about" (I Kings 6:5) and, to our present knowledge, are without exact parallel in the temples of the ancient Near East.

No textual or archaeological evidence has been found for the towers which are so often used in reconstructions.

THE PLATFORM-BASEMENT

The gleaming white *(meleqeh)* limestone used for the Temple walls and raised basement (7½ ft. high) was probably found near at hand, perhaps in quarries under the Temple area. These huge blocks, many twelve and fifteen feet in length, were of uniform tier height (approx. 1½ ft.) and were laid in a pattern of headers and stretchers which we know from excavations at Megiddo and Samaria was "the style" of Phoenician masonry in Solomon's time. The stones were carefully shaped at the quarry. The red paint used as marks for the masons has been found on some of the uncovered blocks. Hence the stones would fit exactly

and without trimming on the site. " . . . there was neither hammer, nor axe, nor any tool of iron heard in the house, while it was building" (I Kings 6:7).

In Mesopotamia where, with soil lacking a rock base, the structures needed a firm foundation, temples had been put on raised basements. Solomon's Temple was built on an ancient rock threshing floor (II Sam. 24:18-25). The function of the raised basement was unnecessary, but the style prevailed.

THE STEPS

Approach to the Porch *(Ulam)* entrance was by a broad stairway.

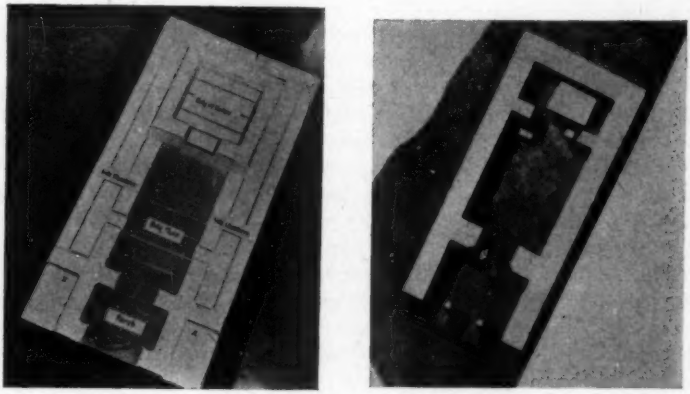

Fig. 4. The Howland-Garber model floor-plan is on the left. On the right, an isometric plan of the Tell Tainat chapel in northern Syria, prepared by the Oriental Institute of the University of Chicago.

The Jewish Talmud tractate *Middoth* (3:6) states that these steps had two intermediate landings.[22] This made impressive the processionals of the priests as they entered the Temple with daily fresh supplies for the Table of Shewbread, incense for the little gold altar and oil for the lamps. The High Priest on the Day of Atonement *(Yom Kippur)* ascended these steps in the sight of Israel on his way into the Holy of Holies there to make atonement for himself and all the people (Lev. 16; Hebrews 9:7).

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20. M. B. Rowton, BASOR 119 (October 1950), pp. 20-22, confirms Dr. Albright's (BASOR, 100, pp. 16-22) dating: Solomon's Temple was begun in Ziv (May) 959/8 B. C. It was completed 7½ years later (1 Kings 6: 1, 37, 38), in Bul (September or October) 951/950 B. C.

21. The Temple was oriented to permit the rays of the rising sun to shine directly into the Holy of Holies at the autumnal equinox: Hollis, **Myth and Ritual** (ed. by S. H. Hooke) pp. 87ff.; H. G. May, **Journal of Biblical Literature**, LVI (1937), pp. 309ff.

22. Translated in Hollis, F. J., **The Archaeology of Herod's Temple with a Commentary on the Tractate "Middoth"** (London, 1934). Also as an appendix to Edersheim's **Sketches of Jewish Social Life in the Days of Christ.**

THE PILLARS JACHIN AND BOAZ

Standing at the head of the platform steps and flanking the Porch entrance were two "pillars of brass," Kings tells us, the one on the "right" named *Jachin*, the one on the "left" called *Boaz* (7:21). Were these names inscribed in some way on the pillars? We do not know. Nor do we know exactly what these words meant. Evidently they were "key words" in some kind of mottoes which, as has been suggested by Professor R. B. Y. Scott, invoked the blessings of God on David's dynasty.[23]

Many authorities have thought of *Jachin* and *Boaz* as columns which supported the Porch roof. Archaeologists today on the basis of much accumulated contemporary evidence are generally agreed that Solomon's *Jachin* and *Boaz* were free-standing pillars, the function of which was not structural but rather decorative and symbolic.[24] The precise meaning of the symbolism is not yet apparent but it is likely that the pillars (as cf. "the pillars of Hercules") were combined in some cosmic meaning together with the Sea and the Mountain-Altar to signify the Lordship of Yahweh over the elements of the natural world.[25]

The Bible does not mention bases for these columns. From archaeological parallels, as at Tell Tainat, it may be assumed that the pillars had bases, probably of stone. An 8th century B. C. pillar base found at Tell Tainat, which is now a part of the Museum of the Oriental Institute, has been copied for the Howland-Garber model.

The shafts of *Jachin* and *Boaz* are described in I Kings 7:15 as 27 ft. high and about 4 ft. in diameter. Some question has been raised as to the accuracy of this latter dimension.[26] The size of the Tell Tainat base persuaded us to adopt the Kings' diameter measurement.

The biblical writer implies that these columns were single castings of "brass," that is to say, of a copper alloy. Professor James L. Kelso and other have indicated the lack of archaeological evidence to demonstrate that the ancients were able to make single castings in such large sizes.[27] From the Balawat gates (early ninth century B. C.), Khorsabad and elsewhere castings of metal plates are known which were made to be fastened to some kind of wood wall or post.[28] It was this suggestion which led us to conceive of these pillars as having been made of cylindrical cast copper plates slipped over a built-up cedar post. This produces a column which appears to be a single casting but which was constructed in a way we know was within the capacity of skilled workmen in the time of Solomon.

The Hebrew text of the passage of I Kings 7:16-20 where the chapiters of these pillars are described is filled with words which appear only here and their usage is evidently technical. Of all the Temple passages, these are perhaps the most difficult to translate visually. The chapiters have been analyzed carefully and clearly by Sir John L. Myres as containing three elements: (1) a bowl member, (2) a leaf member and (3)

the pomegranates.[29] In 1908 G. Schumacher found at Megiddo a chapiter with such elements of design and published it in its original colors with the caption, "an incense burner" *(Raeuchergefass).*[30] This chapiter has the essential elements: (1) a bowl member and (2) a leaf member with the proper "lily work" decoration, and it has been suggested as a suitable design for the *Jachin* and *Boaz* chapiters.[31] We used color film to copy Schumacher's design in its original colors and added strands of (3) pomegranates – 200 on each chapiter in two "rows," i. e. strands of 100.[32] A realistic contemporary pattern of a bronze pomegranate which was found at Megiddo was copied by Mr. Howland.[33]

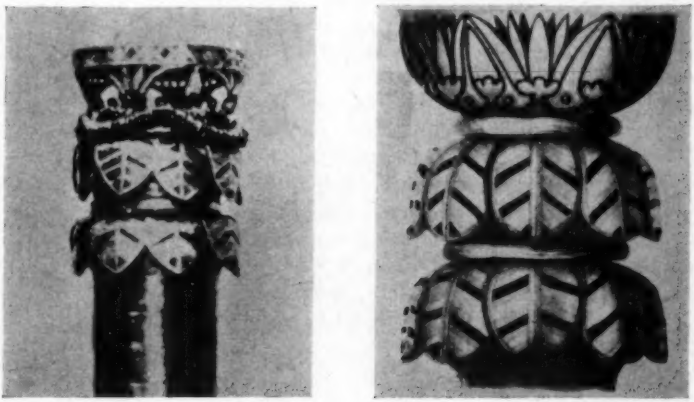

Fig. 5. On the left is the model's rendering of the Chapiters or capitals of the free-standing columns at the entrance of the Temple. On the right is the capital of a column found at Megiddo before the first World War, and thought by the excavator to be a vessel for incense. It furnished the pattern which was copied in the model. (The Megiddo capital is from G. Schumacher, **Tell el-Mutesellim,** Leipzig, 1908, I, frontispiece.)

23. Scott, R. B. Y., **Journal of Biblical Literature,** LVIII (1939), pp. 143ff.

24. Albright, W. F., "Two Cressets from Marisa and the Pillars of Jachin and Boaz," BASOR 85 (1942), pp. 18-27; **Archaeology and the Religion of Israel,** p. 147. For a recent dissenting view see Myres, J. L., "King Solomon's Temple and Other Buildings and Works of Art," **Palestine Exploration Quarterly** (Jan.-Apr. 1948), pp. 27f.

25. Cook, S. A., **The Religion of Ancient Palestine in the Light of Archaeology** (London, 1930), pp. 54ff. Gray, G. B., **Sacrifice in the Old Testament** (Oxford, 1925), pp. 152-153.

26. Albright, **Archaeology and the Religion of Israel,** p. 147.

27. "On the casting of Jachin and Boaz I can find no metallurgist who will make a publishable statement. All that I talked to think it most unlikely that these columns were cast in 27 ft. lengths either 'well type' or 'cope and drag.' " J. L. Kelso to W. F. Albright, July 25, 1947.

28. A Khorsabad example of this repousee work may be seen in the Oriental Institute collection.

29. Myres, J. L., **op. cit.**

30. Schumacher, G., **Tell el-Mutesellim** (Leipzig, 1908) I, frontispiece.

31. May, H. G., "The Two Pillars Before the Temple of Solomon," BASOR 88 (1942), pp. 19-27. Sir John Myres did not consider the Schumacher design in his analysis (**op. cit.**).

32. J. A. Montgomery on I Kings 7:23 in a forthcoming commentary on Kings to be published by Chas. Scribners and Sons, New York.

33. May, H. G. and Engberg, R. M. **Material Remains of the Megiddo Cult** (Chicago, 1935), p. 20, fig. 5. Mr. Howland cast each pomegranate of lead separately making each 1/16 of an inch in diameter.

Dr. Albright thinks these chapiters may have served as braziers for incense or oil.[34] If so, they could have reminded worshippers of the Exodus "pillar of cloud by day" and "pillar of fire by night." The Howland-Garber model is designed with cut out portions of the chapiter to show this possibility, even though it may be difficult to conceive how fluid and fire could be delivered 30 to 35 feet from the platform floor to the chapiter bowl.

THE PORCH

Dr. Wright pointed out in the *Biblical Archaeologist* article (May, 1941) which was adopted as the starting point in the research on the Howland-Garber model that the chapel of the Tell Tainat palace "is the only temple contemporary with the kings of Israel ever found in Syria or Palestine." The floor plan of this structure suggests that the *Porch* of Solomon's Temple was, like that at Tell Tainat, of *liwan* type, i. e. a stoop-like shelter for the main Temple entrance, not an interior room. This impression is confirmed by the fact that in the Kings record (ch. 6) wherever "the house" (i. e. Temple) is used, it refers to the Holy Place and to the Holy of Holies only, excluding the *Porch* as one of the Temple rooms. Furthermore, the record mentions only two sets of doors for the Temple: (1) "for the door of the Temple" (6:33) and (2) "for the entering of the oracle *(Holy of Holies)*" (6:31). No provision for doors into the exterior opening of the *Porch* seems to have been made.

The frame for the model's *Porch* door-way has been adapted from one of the Phoenician Dog River inscriptions which Dr. Albright dates around the time of Solomon.[35]

In three different places in I Kings 6 (vv. 9, 15, 18), the writer mentions that "the house," i. e. the Holy Place and the Holy of Holies, was panelled and ceiled with cedar of Lebanon. In verse 18 he states, "There was no stone seen." The architect seems to have intended the gleaming white of limestone for the exterior walls, the fragrance and rich color of cedar for the interior. It is possible that the *Porch*, not being considered an essential part of "the house," was not panelled. The Howland-Garber model, however, treats the inside of the *Porch* as a part of the interior and shows the cedar wainscotting and the fir (or better, cypress) floor.[36]

THE TEMPLE DOORS

The Temple doors were tall and narrow. The door opening was fifteen feet wide by thirty-three feet high. These dimensions are not specified in the Kings account but are derived from the measurements of the interior room sizes which are given. The doorway size is further confirmed by the necessities of pallet construction as discussed below.

If M. Dussaud is correct in his reading of I Kings 5:18,[37] Phoenician carpenters from Byblos (Giblites) were imported to do the wood

work of the Temple along with their more renowned fellow-craftsmen, the masons and the foresters (5:6, 18). Solomon's conscripted Israelites presumably served as apprentices, as helpers and even as slaves (5:13-16).

Woodcarving is mentioned only in connection with the Temple doors, the doors into the Holy of Holies and the panelling of the Holy Place. Kings describes the design in each case as that of "cherubim and palm trees and open flowers" (6:18, 32, 35); Ezekiel 41:18-20 repeats the description.

Readers of this journal have been made familiar with the design of the cherubim as hybrid creatures, unlike any in this world, part-lion, part-bird and part-human.[38] Palm trees were valued by the ancients for their long life and fecundity.[39] Rosette designs are so common in the

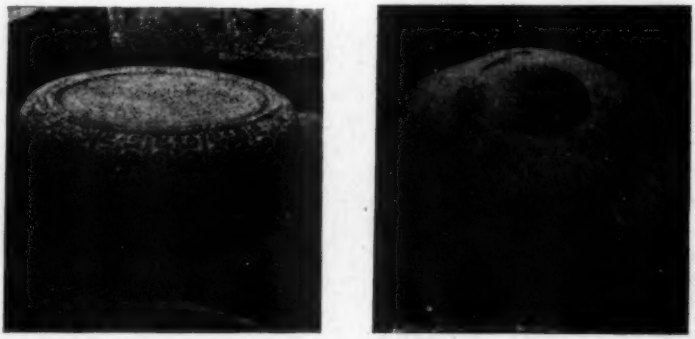

Fig. 6. On the left, a column base from Tell Tainat in Syria. On the right, a stone socket for a door-pivot from Mesopotamia like several found in Palestine. (Both photos from Oriental Institute, University of Chicago)

decorations from Solomon's time that it is difficult to think that "open flowers" could have referred to anything else.

It must have been a rare occasion when these doors were shut, at least in the daytime, for when the Bible speaks of the Temple doors being shut, it is with an ominous note of impending disaster (I Kings 28:24; 29:7; cf. 29:3).

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34. Albright, W. F., BASOR 85 (1942) pp. 18-27.
35. Weissbach, F. H., **Denkmaeler und Inschriften am Nahr el Kelb**, Berlin, 1933; Baedeker, Karl, **Palestine and Syria** (Leipzig, 1912, 5th Ed.) p. 285.
36. The fir or cypress referred to here is not the familiar soft wood but is identified by Dr. Albright as **Cypressus sempervirens**, Cilician cypress, a very hard wood used today in the filigree work for which the Damascus woodcarvers are famous.
37. **Syria** IV (1923), p. 135.
38. Albright, **B. A.**, I, 1 (February 1938), pp. 1-3. Graham and May, **Culture and Conscience** (1936), pp. 195ff, 249ff.; Dhorme and Vincent, **Revue Biblique**, (1926), pp. 328ff., 481ff.
39. Vincent, **Syria** V (1924), pp. 81-107.

These doors swung on metal tipped pivots set in stone sockets. This was a common device for large doors as we know from discoveries of earliest times in Egypt and Mesopotamia. Beneath such stone sockets deposits of valuables and records were often made, as in modern occidental "corner stones." The exposed surfaces of known stone sockets bear engraved exorcisms. Thresholds were considered as needing special attention that the house might be guarded at the entrance against enemies, both human and spirit (I Kings 16:34).

The metal straps binding the doors to the pivots may be what the writer of Kings refers to as "the hinges . . for the temple, of gold" (I Kings 7:50). If so, these straps must have been made of copper or of iron and decorated, possibly overlaid or, more likely, inlaid with gold. The weight supported by these "hinges" would have been excessive for straps made entirely of as soft a metal as gold.

The phrase "a fourth part" in I Kings 6:33, referring to the Temple doorway posts, and its counterpart "a fifth part" in I Kings 6:31, referring to the posts of the doorway between the Holy Place and the Holy of Holies, are linguistic puzzles and without archaeological parallels. The phrases become meaningful in construction when applied to the door-posts and lintels of these doorways in cross-section. The device of rectangular doorposts for the main Temple doors allowed these to stand open at a 90 degree angle. The pentagonal doorposts for the Holy of Holies doorway permitted these doors to swing into the inner sanctuary at a wider angle, thus permitting more of its interior to be seen from the Holy Place than would have been possible otherwise.

THE HOLY PLACE

The Israelite lay worshipper did not enter the Temple. The nearest he got to it was when in the area before the Temple he slaughtered his sacrificial animal and watched a priest put parts of his animal upon the altar. The Israelite priest rarely entered the Temple. When he did so, it was to bring the daily supplies for the Holy Place.

In this sparsely furnished room were some relics from the Tabernacle — an *Incense Altar* (now gold-plated), the *Table of Shewbread* (possibly also "re-finished") and seven-branched *lampstands* (now ten of them instead of the one that was in the Tabernacle). Here fresh bread was displayed daily, twelve "loaves" or cakes, one for each of the twelve traditional Hebrew tribes. Here incense was burned, "a soothing odor to the Lord." The Holy Place must have been impressive with its odors of cedar and incense, the faint light from its latticed windows, the flickering illumination of its olive oil lamps and the dominating doorway of the Holy of Holies and its Mysterious Presence.

Exodus 37:10 describes the *Table* as "of shittim wood: two cubits

was the length thereof, and a cubit the breadth thereof, and a cubit and a half the height thereof" with a "crown of gold around about" and "a border" around about with a "crown of gold for the border." No object exactly like this is known archaeologically. Apparently it was a simple table with some kind of device to keep objects on it from falling from it (the "border" and "crown"). It was equipped with poles so as to be portable. The *Altar* of Incense was also portable. Exodus 30:1-5 gives its dimensions (1x1x2 cubits) and notes it's "horns" and "crown." Dr. Millar Burrows states that "it is practically certain that" the biblical "altar of incense" was like an altar with "horns" found at Megiddo.[40] The Kings account does not specify that either the *Table* or the *Altar* of *Incense* was moved into the Temple from the Old Tabernacle. Perhaps this was assumed.

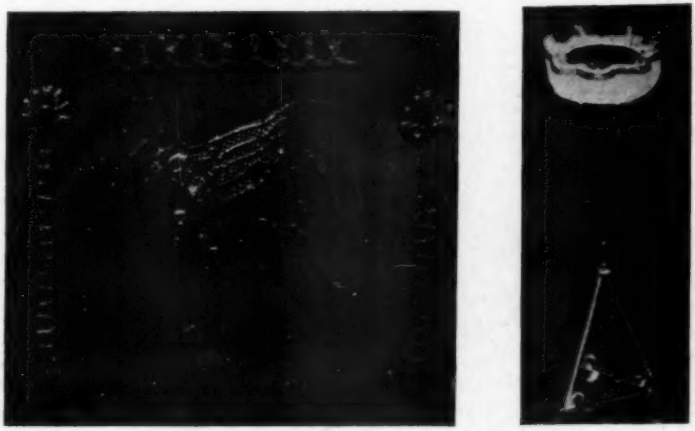

Fig. 7. On the left are the cherubim, palm and lily decoration, made of gold, and used for the decoration of the lower part of the interior walls of the Temple-model (see Fig. 1). On the right, one of the ten "seven-branched" lamps and its stand, the latter modelled after one discovered at Megiddo.

A single seven-branched "candelabrum" is said to have illumined the Holy Place of the Tabernacle (Ex. 25:31; 37:17). The Temple Holy Place has ten (I Kings 7:49). We have no evidence concerning the lampholders, as the word translated "candlestick" (AV) more specifically means. The discovery at Megiddo of a metal stand with a tripod base served as our pattern, though similar "offering stands" have been discovered at Beisan and elsewhere, some being dated as early as the 12th

40. **What Mean These Stones?** (New Haven, 1941), p. 48; May and Engberg, **op. cit.**, Pl. XII.

century.[41] If the *Menorah* form of the seven-branched candlestick or lampstand was used in the period of the Israelite monarchy, the example is not widely known. Clay lamps made as bowls to hold olive oil and with seven wicks to each lamp, on the other hand, are known in nearly all periods of Israel's history and may be confidently assumed to have been in use at the time of Solomon.

The flooring of the Holy Place in the Howland-Garber model shows the six-pointed design, commonly known as the Star of David. This design, which was once not considered ancient, was found at Megiddo clearly incised on one of the stones excavators date from the time of Solomon.[42] The pattern of bracing made by this design forms the framework by which the entire 30 ft. by 60 ft. floor space could have been covered by a single pallet.

A pallet, in this sense, may be described as a large, self-supporting member constructed of joists and beams on a consistent pattern of stresses and strains. It is a kind of framework which may be covered with boards to serve as a floor, as a ceiling or as a panelled wall.

Making such pallets involves the use of nails. The discovery of wrought copper spikes and nails at Ezion-geber, Solomon's Copper Smelter, was one of Dr. Glueck's contributions to our knowledge of the age of Solomon.[43]

I Kings 6:7 states that Solomon's Temple was erected without sound of hammer or any other tool of iron being heard while it was being built. This means that all the woodwork of the Temple was assembled outside the Temple area and brought in silently as prefabricated sections or pallets. If so, the ceilings of the Porch, the Holy Place and the Holy of Holies were placed first, the wall panelling pallets in each room were placed next and the floor pallets were put down last, locking the wall pallets at the bottom as the weight of the ceiling pallets held the wall pallets at the top.

An additional device to bind the wood panelling to the thick stone walls may have been used. Wooden beams on the reverse side of the wall panels could have been designed to fit snugly between courses of stone masonry. When, through moisture acquired from the air, these beams expanded, the panels would have been quite securely locked in place and that with "neither hammer nor axe nor any tool of iron heard in the house, while it was building" (I Kings 6:7).

The "windows of narrow lights" ("latticed") of I Kings 6:4 are recognized by archaeologists now, according to Dr. Wright, as the Talmudic "Tyrian window," known best from the widely found ivory carvings of the goddess of fertility looking out of the window in the guise of a sacred harlot.[44] Dr. Albright suggested that windows of this type

could be closed by lifting the column-slats from their wells at the bottom of the window-frames and that in the Temple clerestory these windows were permanently closed.

The "pillars" of I Kings 10:12 are interpreted in the model as pilasters of the Holy Place. There was no structural necessity for interior pillars in this room; cedars of Lebanon were of ample size to produce the beams needed to span the ceiling and support the roof (approx. 35 ft.). These tall pilasters, on the other hand, add a sense of height to the room and mark off the wall panels for the wainscoting and the clerestory

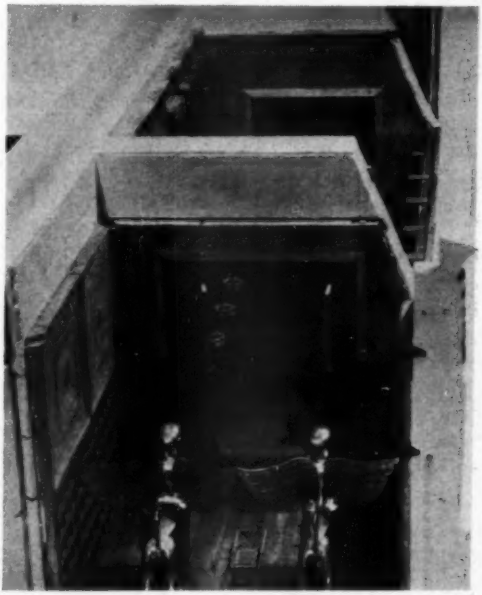

Fig. 8. View of the model's interior from the "Holy of Holies" with the roof removed. Note the "star of David" design in the flooring of the "Holy Place."

windows. On the face of the pilasters and at the height of the wainscoting, "trees of life," as palm trees were considered, were carved. The wood said to have been used for these pilasters is given in Kings as "almug" and in Chronicles as "algum." This is now identified as East

41. May and Engberg, **op. cit.**, p. 19, Pl. XVII.
42. **Ibid.**, p. 6, fig. 1.
43. Glueck, Nelson, **op. cit.**, Pl. 10.
44. Wright, G. E., **B. A.** IV, 2 (May 1941), p. 26, fig. 7.

Indian sandalwood *(santalum album)*, a close-grained, yellowish wood much used in ornamental carving and cabinetwork; its odor drives away insects, and it is therefore of value for chests and boxes.

The volute capitals of the Holy Place pilasters are often called "Proto-Ionic" since known examples from the ancient Near East antedate similar Greek designs by more than seven hundred years.[45] The model capitals duplicate the lines of a stone capital found at Megiddo associated with a "temple" of about the time of Solomon.[46]

The carved wainscoting of the Holy Place wall panels went all around the sides of this room at a height of 7½ ft. from the floor. I Kings 6:18 describes this carving as designed in "knops and open flowers" i. e. egg-shaped gourds and rosettes: cf. the model's border of open lilies and buds of the Holy Place carved wainscoting. I Kings 6:29 and Ezekiel 41:18-20 add cherubim and palm trees. The exact repetition of design appears to have been a style of decoration in Solomon's day. In this case it must have been effective in creating within the Holy Place the desired "other world" atmosphere.

It has been recognized that the writer of Kings is quite generous in his use of gold "over-lay;" for example, 6:30 where the floor of the Temple was "over-laid" with gold. Dr. Wright suggests that "in-laid" is a more accurate translation of this verb.[47] This appears a more suitable rendering in each of the places where the verb occurs, especially I Kings 6:21, "So Solomon overlaid the house within with pure gold:" with its implication that the elegance of cedar and the artistic wood carvings were all blended in a single covering sheath of gold leaf! "Highlighting" the carvings by the use of gold in-lay, on the other hand, could have increased the effectiveness of the craftsman's art.

The Holy Place ceiling poses the interesting query: How did the ancients produce a waterproof flat roof? Supporting the ceiling pallet below were heavy decorated beams. Commenting on I Kings 6:9, the late Dr. J. A. Montgomery wrote in reference to the ceiling of the Holy Place, "The crossing of the rafters at right angles formed hollow squares, in technical phraseology, *coffers;* these may have been further set forth by decoration as in modern architecture."[48] Reconstructed according to this analysis, the Holy Place ceiling resembles strikingly the ceiling patterns of Khorsabad, as worked out by the Oriental Institute, and of Egypt.[48a] Above the interior ceiling was probably a layer of brush packed with clay. This was topped by a thick layer of "limestone marl" which was rolled flat by stone rollers of which we have surviving examples from Beisan and elsewhere. After this soft and moist substance had dried in the sun, it was as smooth and as hard as modern concrete, and probably almost as impervious to water.

THE SIDE CHAMBERS

In the opinion of Professor Carl Watzinger, the most significant architectural feature of Solomon's Temple was the addition of side rooms to serve as "treasure chambers." Vaults for valuables had appeared earlier in connection with temples of the East (Mesopotamia). But not until Solomon's time was this feature introduced into temples of the West.[49] Watzinger's reconstruction drawings, [50] however, show the doors to these "treasure chambers" on the exterior of the Temple, following a tradition based on the usual reading of I Kings 6:8: "The door . . . *was* in the right side (shoulder, marg.) of the house *(hekal,* i. e. Holy Place)." Professor Leroy Waterman interprets this text to mean, as appears more likely, that access to "safety deposit vaults" was from the *interior* of the Temple, rather than by some "back" or "side" exterior door.[51] That these Temple side chambers were used as a repository for objects of material wealth is clear from the repeated use of the phrase "the treasures of the house of the Lord" in connection with, and independently of, the phrase "the treasures of the king's house."[52] Whether monarch or priest were owners of such treasures we may not know, but it was plain to the writer of Kings that foreign conquerors from "Shishak" (I Kings 14:26) to Nebuchadnezzar (II Kings 24:13) sought for and found loot useful to their purposes not only in the palace buildings of the king but also in the Temple. (Chronicles takes pains to distinguish carefully between these two "treasuries" and their respective administrations: I Chron. 26:20 and 27:25.) Storage must have been provided in the Side Chambers also for many priestly garments and much ritual paraphanalia. It should be noted that Kings does not mention windows for the Side Chambers. Wherever Jehosheba hid baby Joash from the wrath of Queen Athaliah "in the house of the Lord six years" (II Kings 11:3), it was scarcely in the unlighted Side Chambers of the Temple.

The capital of the doorway from the Holy Place into the Side Chambers is reconstructed of the Proto-Ionic type and placed within a doorframe set in a thick masonry wall in accordance with a suggestion by Mr. T. A. L. Concannon who assisted the Oriental Institute expedition at Megiddo.[53]

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45. May and Engberg, **op. cit.**, pp. 39-42, where this type of capital is traced to the 12th century B. C.
46. **Ibid.**, pp. 7, 10, Pl. X.
47. Wright, G. E., **op. cit.**, p. 21.
48. Montgomery, J. A., **op. cit.**
48a. Davis and Gardner, **Ancient Egyptian Paintings** (Chicago, 1939).
49. Watzinger, Carl, **Denkmaeler Palaestinas** I (Leipzig, 1933).
50. These drawings were reproduced in **B. A.**, IV, 2 (May 1941).
51. Waterman, Leroy, "The Damaged 'Blue Prints' of the Temple of Solomon," **Journal of Near Eastern Studies**, II, 4 (October 1943), pp. 287-288.
52. I Kings 7:51; 12:18; 14:14, 26; 15:18; 16:8; 18:15; 20: 13, 15; 24:13.
53. May and Engberg, **op. cit.**, Pl. VI; after the analogy of a Tamassos (Cyprus) tomb doorway, **Ibid.**, p. 11.

Various attempts have been made to translate the Hebrew phrase of I Kings 6:8 rendered in the A. V. as "winding stairs," and the precise meaning is still far from clear. It refers to some means of getting from the lowest story of the Side Chambers to the second and thence to the third. The English phrase "winding stairs" connotes winding steps, perhaps steps in a spiral arrangement around a central post. No such device is known archaeologically from Solomon's time. All the phrase requires seems to be met, as Dr. Waterman has suggested, by the "winding" of *flights* of stairs, so that a flight of steps from first to second story goes from the doorway toward the front of the Temple, the "path" of the stairs leads "around" by a landing to a second flight of steps which leads from the second story to the third in the opposite direction to that followed by the lower flight.[54]

The three floors of storage space in the Side Chambers probably had some kind of partitions and divisions. What these were we do not know. Ezekiel 41:6 in translation leaves the impression that there were thirty-three cubicles on each of the three floors, making ninety-nine in all. This is the usual interpretation and is followed uncritically by Watzinger and others. Dr. Waterman holds that the Ezekiel statement means three superimposed storage cells or vaults. The simplicity of this interpretation appears consonant with the Temple in the time of Solomon, whatever elaborations by way of interior partitioning may have been made later.[55]

THE HOLY OF HOLIES

I Kings 6:2 and 20 specify that the interior ceiling height of the Holy Place was 30 cubits (approx. 45 ft.) while that of the Holy of Holies was 20 cubits (approx 30 ft.). Professor Kurt Galling has suggested that the *sanctum sanctorum* of Solomon's Temple, like the inner sanctuaries of Canaanite temples such as those at Beth-shean, had a floor elevated above that of the rest of the Temple.[56] This plan is followed in the Howland-Garber model, the floor of the Holy of Holies being 7½ ft.. above that of the Holy Place. The Holy of Holies ceiling is suspended 7½ ft. below that of the Holy Place to make the inner sanctuary a cube on the inside of 20 cubits.

The stairs leading to the Holy of Holies doorway catch the eye of the observer and lead it to the Ark and its protecting giant statue-cherubim which that doorway frames. (The veil, presumably for this doorway, which is mentioned in II Chronicles 3:14, is not noted in the Kings record where the doors are specified in detail; the veil may have been added later but apparently it was not a part of the Temple in the period of the monarchy.)

I Kings 6:16 speaks of the partition between the Holy Place and the Holy of Holies as having been built "with boards of cedar from the floor"

to the ceiling. It seems scarcely likely that with all other walls in the Temple 7½ ft. thick that this wall should have been just the thickness of cedar boards.[57] The model incorporates a masonry partition and thus agrees with the floor plan of the Tell Tainat chapel. The cedar panelling may have given the impression that this partition was solely of wood.

The doorposts and lintels of the Holy of Holies' doors, as those of the exterior Temple doors, were made of olive-wood. The outside Temple doors were made of the darker cypress ("fir") while the interior sanctuary doors were made of the light-colored olive-wood. Both sets of doors were carved with decorations described by the same phrase, "cherubim

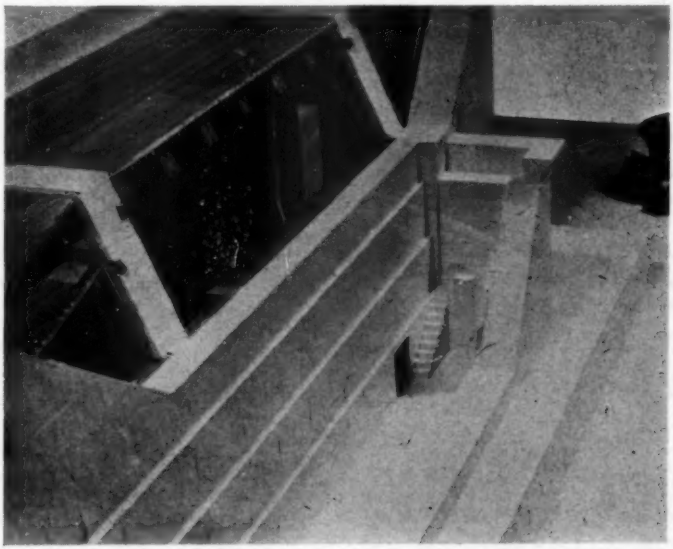

Fig. 9. A plausible interpretation of the "winding stairs" in the Side Chambers.

and palm trees and open flowers." Probably the Holy of Holies doors were the more elaborately "inlaid" with gold; the Kings description specifies gold "overlaying" for both sets of doors (I Kings 6:31-35). It was this doorway which had the unusual "pentagonal" doorposts mentioned above.

54. Waterman, Leroy, **op. cit.**
55. **Ibid.**
56. Galling, Kurt. "Das Allerheiligste in Salamos Tempel." **Journal of the Palestine Oriental Society**, XII (1931), pp. 43-48. His plan to elevate the Holy of Holies by 15 cubits (approx. 22½ ft.) creates more problems than it solves.
57. Thick masonry walls are characteristic of Phoenician construction. The 7½ ft. measurement adopted in the model was derived from the Watzinger drawings.

In the Howland-Garber model the "chains of gold across before the oracle" of I Kings 6:21 appear as loops on the face of the Holy of Holies doors. The phrase may apply to some kind of a decorative motif carved on the wood panelling of the Holy Place wall; this sort of ornamentation was well known among Phoenician workmen in Solomon's time.[58]

On the day Solomon moved the furnishings of the Tabernacle into the new Temple, the *Ark of the Covenant,* which had had a long and somewhat checkered career as a sacred object for the Israelites, was the center of the great procession. It was placed in the most prominent position in the new structure, was provided there with two giant cherubim as perpetual protecting escorts and could be seen through the open doorway by the ordinary priests in the round of their duties in the Holy Place. "The glory of the Lord (first) filled the house of the Lord" when the priests had moved the *Ark of the Covenant* into the Holy of Holies (I Kings 8:11).

Solomon's Temple was distinguished from all the known temples of the ancient world for having not one single idol. In place of an idol, there was an old and simple box, arranged with poles so it could be carried. I Kings 8:9 states: "There was nothing in the ark save the two tables of stone which Moses put there at Horeb (Mt. Sinai), where the Lord made a covenant with the children of Israel, when they came out of the land of Egypt."[59]

The *Ark* was old (Ex. 25:10f.). Its contents were without material value. But its lid was called "the *seat* of Mercy." The Lord God, whom "neither the heaven nor the heaven of heavens can contain" did not dwell in a temple made with hands nor needed any such temple, but in response to His people's prayer, He had graciously heard in heaven, His dwelling place, and had said of Solomon's Temple, "My Name shall be there" (I Kings 8:29).

"The God of Israel," Dr. Wright says, "is often designated as 'He who thrones (or is enthroned upon) the cherubim.'"[60] The second commandment prohibited images of God. His Presence may have been thought of as invisibly enthroned upon the Ark and between the cherubim, or perhaps above them both. These were guardians of the Temple even as they were at the east of the Garden of Eden (Genesis 3:24). They may also have been considered God's aids in His moving from place to place; "and He rode upon a cherub and did fly" (II Sam. 22:11; Ps. 18:10; to which compare Ezek. 10:20). In any case, these sizable carved and gold-covered statue-cherubim of the Holy of Holies served visually to give cosmic dignity to the Invisible God to Whom cherubim and seraphim do continually cry, "Holy, Holy, Holy; Holy is the Lord God of Hosts; the whole earth is full of His glory" (Isa. 6:3).

THE TEMPLE DESIGNED WITH THE ARK AS CENTER

In many ways the most satisfying view of the Howland-Garber model is that of the interior seen through the aperture of the front entrance. I am inclined to feel that this aesthetic feeling is the result of design on the part of the original architect.

The lines of the Temple interior are arranged length-wise from the Porch to the Holy of Holies. The largest opening in the interior is that of the open side of the *liwan* Porch. The next largest opening is that of the Temple exterior doors. The smallest opening is that to the Holy of Holies.

Fig. 10. The doorway of the "Holy of Holies" and steps leading up to it from the "Holy Place."

The eye-level of an observer of the Temple from the exterior court would be approximately the level of the Porch floor. His eye would be taken to that level by the platform steps. The eye is taken by the Holy of

58. Loud, Gordon, **The Megiddo Ivories** (Chicago, 1939), Pl. 20.

59. There have been those who have questioned this traditional description of the Ark: e. g., Morgenstern, Julius, **The Ark, the Ephod and the "Tent of Meeting,"** (Cincinnati, 1945). May, H. G., "The Ark — a Miniature Temple," **American Journal of Semitic Languages and Literatures,** LII, 4 (July 1936), pp. 215-234. Arnold, W. R., **Ephod and Ark (Harvard Theological Studies** III, 1917).

60. Wright, G. E., **B. A.,** IV, 2 (May 1941) p. 28.

Holies' steps to the floor level of the Holy of Holies. At the same time, the reverse "stepping" of the ceiling levels takes the observer's attention from the ceiling level of the Porch down to the Holy of Holies' doorway. Evidently this doorway was intended by the designer to frame some object upon which he wished the undivided attention of the viewer to be directed.

The model has a cut-away side with a strong illumination from that side. The original structure had a darkened cella (Holy of Holies) and a Holy Place which was lighted only by "windows of fixed lattice work" in clerestory lighting and by ten pottery lamps; not much illumination, it must be admitted. Yet the model raises the interesting query whether it was ever possible for the strong Palestinian sunlight so to illuminate the inside of the Temple as to show its arrangement and furnishings to viewers standing in the court outside. If so, those favored with such a sight would have joined the priests in the Holy Place in being conscious, by the design of the architect, of that darkened doorway into the Holy of Holies which framed symbols of the Mysterious Presence, the *Ark* and its attendants, the giant cherubim.

SIGNIFICANCE

The most famous of the Jerusalem Temples is known as Solomon's. It was, as the Bible clearly states, designed and constructed by Phoenicians. These people, we now know from archaeology, had a style of architecture all their own. They were influenced by Egypt, mainly the Egypt of an earlier period. (An example of this is the Egyptian "streamlined cornice" used on the Howland-Garber model as it was on the Karnak Temple some three centuries before the time of Solomon and on Phoenician clay model shrines made in the Israelite period and found at Megiddo.[61]) Phoenician architects were influenced from other quarters as well. Solomon carried on trade with South Arabia, Hittite North Syria and Cilicia and conducted trading expeditions on the Red Sea and Indian Ocean. The Phoenicians were Solomon's examples and tutors in commercial expansion. They had colonies at least as far west as Sardinia ("Tarshish") and were engaged in copper mining both there and in Cypress. Everywhere they went, they evidently were both teachers and learners in the arts. What they learned, they did not imitate; they incorporated it into their own mode and style. Rapidly increasing discoveries archaeologically, at Arslan Tash, Ras Shamra, Byblos, Tell Tainat, Megiddo, Samaria and elsewhere are revealing a wide-spread "climate" of commonly used techniques of the building arts and of decorative design.[62]

The Temple was erected by Phoenicians. The Hebrews quickly and thoroughly made it their own. The Books of Kings, writes Rabbi I. W. Slotki, "dwell on three theocratic institutions which symbolize the Pres-

ence of God among His people: the Temple, prophecy and the Davidic dynasty. The neglect of any one of them is a deviation from the right path, endangering the peace and existence of the nation."[63]

The fact that Judah had the Temple during the years of her separate existence tended to keep her from imitating some of the ways of her northern sister nation, Israel, ways of infidelity to the Lord. When from 598 to 586 (or 587 in Dr. Albright's dating), as Judah went into that rapid national decline which ended at last in defeat and disaster, it became increasingly clear to Jeremiah and others like him that this fate was largely due to the fact that the Temple's services had lost meaning

Fig. 11. View of the model's front elevation and its interior as seen from the court. (Photo by Carolyn Carter)

for the people and the Temple itself had become an object of superstition, its name being used in formulae of magic (Jer. 7:4, 11).

By the time Jeremiah's views were popularly acknowledged to be true, however, the Temple of Solomon was dust and ashes, a victim of

61. May and Engberg, **op. cit.**, p. 17, Pl. XV.
62. Dr. W. F. Albright discussed the Phoenician data relevant to the Solomonic age in **Studies in the History of Culture** (Waldo Gifford Leland volume, 1942). Much additional material has become available since, which is yet to be collected.
63. Slotki, I. W., **Kings**, (London: Soncino Press, 1950), p. xi.

the hot fires of punitive war (II Kings 25:9; II Chron. 36:19; Ps. 79:1; Lam. 2:7).

"The former things have passed away" (Rev. 21:4 RSV, cf. Haggai 2:9).

A NOTICE

The Howland-Garber model reconstruction of Solomon's Temple is on display at Agnes Scott College, Decatur, Georgia, where visitors to the Atlanta area may see it. There is available from Mr. E. G. Howland, 609 Michigan Avenue, Troy, Ohio, a booklet of views showing the model both in its final form and in various stages of construction, together with descriptive text. The price of this booklet is $1.00.

Southeastern Films, Mortgage Guarantee Building, Atlanta 3, Georgia, has produced for Mr. Howland and Dr. Garber a 35 mm. film strip entitled, "The Temple of Solomon." Photographs in the booklet and others associated with the archaeological parallels to the building are included in the film strip. The manuel accompanying the film strip Dr. Garber has prepared for use in classroom Bible instruction. The film strip, like the booklet, is being sold below cost to make it available to a wider group and is being distributed by Southeastern Films at the price of $2.50.

DUPLICATE MODELS?

The Editor of this journal has been in correspondence with Mr. Howland about the possibility of preparing duplicate models of the Temple which might be sold to institutions and individuals for teaching and display purposes. The original model is filled with such intricate and extraordinarily detailed handwork that the problem is to produce duplicates of it with enough realism in appearance and design at moderate cost.

Mr. Howland feels that a duplicate model or mock-up with enough realism to approach the appearance of the original would have to be priced between $80 to $100. To do it at all, however, would necessitate a number of orders. If at all interested, please write to Mr. Howland. 609 Michigan Ave., Troy, Ohio, as soon as possible. He is desirous of learning whether or not a market exists for such a thing.

Another approach to the problem of model duplication, one particularly pertinent for Sunday School work, is via cardboard or other material, on which design might be stamped and from which the pieces might be cut and fitted together. Any interest which you might have in this proposition would also be appreciated. Again please write to Mr. Howland.

G. E. W.

NEW RADIOCARBON METHOD FOR DATING THE PAST*

Donald Collier
Curator of South American Ethnology and Archaeology
Chicago Natural History Museum

The commonest and usually the first question asked by visitors to archaeological digs and museums is "How old is it?" This general curiosity about the age of things made by man in the past is shared by archaeologists, for it is impossible to reconstruct the history of ancient civilizations without chronology. In the absence of written records, like those left by the ancient Egyptians and Mayas, archaeologists have had to depend on indirect methods for determining time sequences in the past. The single exception is that of the American Southwest where, thanks to the tree-ring method of dating, it has been possible to trace with great accuracy the history of Indian cultures during the past 2,000 years. The indirect methods, such as stratigraphy, typological cross-dating, and correlation of human remains and artifacts with geological events and climatic changes, are laborious and inaccurate and do not yield dates in years but only relative sequences.

The new method of radiocarbon dating, developed by Dr. Willard F. Libby at the Institute for Nuclear Studies of the University of Chicago, promises to revolutionize dating problems in archaeology. This method determines the age of things that lived during the past 20,000 years by measuring the amount of carbon 14 they contain.

Carbon 14 is an unstable (radioactive) heavy form of carbon with an atomic weight of 14. Normal, stable carbon has an atomic weight of 12. The half-life of carbon 14 is about 5,500 years. This means that an ounce of carbon 14 is reduced by decay to half an ounce in 5,500 years, that half the remainder decays during the next 5,500 years, leaving a quarter of an ounce, and so on.

Carbon 14 is constantly being formed in the earth's upper atmosphere as the result of the bombardment of nitrogen-14 atoms by cosmic rays (neutrons). The carbon-14 atoms thus created combine with oxygen to form carbon dioxide, which becomes mixed in the earth's atmosphere with the vastly greater proportion of carbon dioxide containing ordinary carbon atoms. The carbon 14 then enters all living things, which, through the life process, are in exchange with the atmosphere. This exchange is carried out through photosynthesis in plants. Dr. Libby has shown experimentally that all living matter contains a constant proportion of carbon 14, which is about one trillionth of a gram of carbon 14 to each gram of carbon 12. This constant proportion results from the equilibrium between the rate of formation of carbon 14 and the rate of disintegration

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of the carbon 14 contained in the atmosphere, in the ocean, and in all living things.

When a plant or an animal dies, it ceases to be in exchange with the atmosphere and hence there is no further intake of carbon 14. But the carbon 14 contained at death goes on disintegrating at a constant rate, so that the amount of carbon 14 remaining is proportional to the time elapsed since death. Given the carbon-14 content of contemporary living matter and the disintegration rate of carbon 14 (the half-life), it is possible to calculate the age of an ancient organic sample from the amount of carbon 14 it contains.

SAMPLES ARE BURNED

The laboratory procedure consists of burning the sample to be dated, reducing it to pure carbon, and measuring its radioactivity (rate of atomic disintegration) in a specially constructed, extremely sensitive radiation counter (a form of Geiger counter). The measurement is expressed in terms of the number of carbon-14 disintegrations per minute per gram of carbon. This value is 15.3 for contemporary living samples, 7.65 for samples 5,568 years old, and 3.83 for samples 11,136 years old. Very old samples contain such a small amount of carbon 14 that the error in counting becomes very large, so that the effective range of the method with present techniques is something less than 20,000 years. But there exists a method for enriching or concentrating the carbon 14 in a sample that may make it possible to obtain useful dates back to 30,000 years. At present the year error in dating samples ranges from 5 to 10 per cent.

Although carbon 14 is present in all organic matter, certain kinds of material have been found to be most useful for dating. These are plant material and wood, charcoal, shell, antler, burned bone, dung, and peat. Unburned bone appears to be unreliable because it is more easily altered chemically than these other materials and hence may lose or gain carbon-14 atoms by exchange during the time between death of the animal and the present.

This method has the disadvantage that the sample to be dated must be destroyed by burning. However, in most cases this is not serious because the size of the sample needed is relatively small. The minimum amount of pure carbon necessary for a single counting run (the amount of carbon placed in the Geiger counter) is 8 grams (about a third of an ounce). Since the carbon content of different organic materials varies, the size of the sample needed to yield this much pure carbon also varies. In general, it is necessary to have about 2 ounces of plant material or wood, 1 to 3 ounces of charcoal, 4 ounces of shell, 5 to 10 ounces of dung or peat, and one to several pounds of antler or burned bone. For the greater accuracy obtained by making two independent counting runs these quantities would need to be doubled.

HISTORY OF PROCESS

A brief review of the history of the development of radiocarbon dating will help to make clear the nature of the method. In 1934 shortly after the discovery of artificial radioactivity, Dr. A. V. Grosse predicted the possible existence of radioactive elements produced by cosmic rays. In 1946 Dr. Libby predicted that natural or "cosmic" carbon 14 would be found in living matter. The following year he and Grosse checked this hypothesis by testing methane gas derived from sewage (an organic product) and found carbon 14 to be present in the expected amount.

The next step was to test the assumption that carbon 14 was present in the same concentration in all living matter. This research, called by Dr. Libby a "world-wide assay of natural radiocarbon," consisted of measuring the carbon-14 content of contemporary living material from various parts of the world, various latitudes, altitudes, and geographical situations. This Museum contributed to this part of the research by furnishing from the botanical and anthropological collections wood samples from the Pacific Ocean, South America, Europe, Africa, and the Near East. These measurements, made by Dr. E. C. Anderson, confirmed the assumption and established the value for the carbon-14 content of present-day living matter.

EGYPTIAN BOAT PLANK USED

The next phase, carried out by Dr. J. R. Arnold and Dr. Libby, consisted of testing the dating method by measuring some ancient samples of relatively accurately known age. These were wood from Egypt and Syria, a sample of wood dated by tree-rings, and a piece of old redwood. They ranged in known age from 1,300 to 4,600 years. One of the Egyptian samples, which was supplied by this Museum, was a piece of deck plank from the mortuary boat of King Sesostris III, who died about 1849 B. C. The dates obtained on this and the other samples agreed with the known ages within the calculated error of the method.

The final phase of this research has consisted of further checking of the method by dating selected archaeological and geological samples of unknown age. An effort was made to obtain from various parts of the world samples whose relative age had been established by the usual archaeological and geological methods. In some instances it was possible to secure several samples coming from different layers of a single stratified deposit. These stratified series were particularly valuable in testing the consistency of the carbon-14 dates obtained. Up to the present more than 150 samples of unknown age from North and South America, Europe, and the Near East have been dated. These range in age from a few centuries to more than 20,000 years, and relate to the problems of dating early man in North and South America; the Archaic Indian cultures of the eastern United States; the early cultures of the

Southwest, Mexico, and Peru; the Late Paleolithic, Mesolithic, and Neolithic periods in Europe and the Near East; and the last glaciation in North America and Europe.

TEST MUSEUM SPECIMENS

Among these samples were several furnished by this Museum. Two were portions of wooden implements from the Early Nazca culture on the south coast of Peru, excavated by a Museum expedition in 1926. Dr. Libby's results show them to be about 2,000 years old, which is consistent with other carbon-14 dates obtained from Peruvian samples. Two other samples were charcoal from hearths belonging to the Chiricahua stage of the Cochise culture in western New Mexico. These hearths were discovered by the Museum's 1950 Southwest Archaeological Expedition. The carbon-14 date indicates that these hearths were in use about 2500 B.C. This date is consistent with one obtained from a site of the Chiricahua stage in Arizona. Samples of charcoal, bark, and wood from the Hopewell culture of Ohio were also given to Dr. Libby. These turned out to be considerably older than archaeologists had believed.

Full assessment of the results of the final phase of Dr. Libby's research on radiocarbon dating has not been made. But the general consistency of the results, including the dates on samples from periods older than 5,000 years, for which there are no absolute dates for checking, leaves little room for doubt that the method is sound and that dates accurate within the experimental error of the method can be obtained. Radiocarbon dating is destined to have a very important role in archaeology, both in increasing the accuracy of its findings and in reducing the amount of time and effort devoted to problems of dating. This will mean that, in the future, archaeologists can move on with greater facility to the syntheses and generalizations that are the ultimate aim of their work.

The method will be extremely useful also in the aspects of geology, paleontology, and paleobotany dealing with events and processes that occurred during the past 30,000 years. Dr. Libby has already obtained dates relating to the time of the last glaciation in North America and Europe. These dates indicate that the last glaciation was considerably more recent than accepted geological estimates. It will be possible with additional work to date the retreat of the glaciers quite accurately, and this information will have a crucial bearing on time estimates for the whole Pleistocene period, which is variously estimated to have lasted from 400,000 to 1,000,000 years. Radiocarbon dating will also give more reliable information on the time required for the formation of new species among plants and animals. In these and many other ways carbon-14 dating promises to be an extremely important scientific tool.

DATE OF CLOTH FROM THE 'AIN FASHKHA CAVE

O. R. Sellers
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Along with the pieces of manuscript and pottery which were found by Mr. G. Lankester Harding and Father R. de Vaux in their excavation of the 'Ain Fashkha cave in early 1949, there was a quantity of linen cloth (BASOR 118, Apr., 1950, pp. 9-10). From the bedouin who brought to him the Dead Sea Scrolls, the Syrian Metropolitan, Mar Athanasius Yeshue Samuel, had secured similar cloth, in which the scrolls were reported to have been wrapped. A piece of cloth from the cave and a piece of the Metropolitan's cloth were on display at the recent exhibition of the scrolls at the Oriental Institute, University of Chicago.

All archaeologists who have seen the pottery from the cave agree to its Hellenistic date (2nd to 1st century B. C.) The possibility of dating the cloth came with the development of the Carbon 14 process at the Institute for Nuclear Studies of the University of Chicago. So it was suggested to Mr. Harding that he send over enough of the cloth to be measured. He readily agreed and the cloth was brought to America by Professor J. L. Kelso when he returned from Jordan after his year as director of the American School of Oriental Research in Jerusalem. Through Professor Carl Kraeling the cloth was turned over to Professor W. F. Libby of the Institute for Nuclear Studies.

On January 9 Professor Libby reported to Professor Kraeling: "We have completed a measurement on the linen wrappings from the Dead Sea Scrolls which you furnished us on November 14, 1950 . . . . The date obtained is 1917, plus or minus 200 years, or 33 A. D., plus or minus 200."

Thus the cloth by the Carbon 14 process is dated between 167 B. C. and 233 A. D. So epigraphy, archaeology, and nuclear physics now combine to support the genuineness and antiquity of the material found in the cave.

Archaeological News and Views

ASOR CELEBRATE FIFTIETH ANNIVERSARY

The year 1950 marked the fiftieth anniversary of the American Schools of Research, a cooperative organization of a large number of American educational institutions, which are members of its corporation. In a joint meeting with the Society of Biblical Literature and Exegesis and the National Association of Biblical Instructors in New York on December 27 and 28 the American Schools celebrated the event with appropriate ceremonies. On Wednesday, the 27th, the trustees were entertained at a lunch given by Mr. Louis M. Rabinowitz in the Waldorf-Astoria and at five o'clock Mr. and Mrs. Rabinowitz gave a party for the trustees, their wives, and a few other guests.

At a following dinner in the Faculty Club of Columbia University one hundred and twenty-five persons connected with the Schools listened to brief talks by past directors of the Schools at Baghdad and Jerusalem. President Carl H. Kraeling presided. Professor E. A. Speiser, former director at Baghdad, and Professor W. F. Albright, Professor Millar Burrows, and President Nelson Glueck spoke of their experiences in the Jerusalem School. Professor Benjamin Maisler of the Hebrew University, Jerusalem, presented the Schools with a plaque containing greetings from his institution. The feature of the occasion was a talk by Professor C. C. Torrey, who went out fifty years ago to establish the School in Jerusalem. His story of the problems of transportation and of securing necessary authority from the Turkish officials was highly interesting.

On Thursday, the 28th, the alumni luncheon was held in the refectory of the Jewish Theological Seminary with Professor H. S. Gehman presiding. There were brief speeches by Professors A. Henry Detweiler, Albrecht Goetze, and James L. Kelso. In the evening at the joint meeting in Union Theological Seminary Professor James Muilenberg gave the annual report to the Society of Biblical Literature and Exegesis, and Professors J. L. Kelso and Kenneth W. Clark gave illustrated accounts of their work in Jerusalem, Jericho, and Sinai during the 1949-50 season.

To commemorate this fiftieth anniversary the Schools have issued a new catalog.

O. R. S.

SOME RADIOCARBON DATES

In September, 1950 Professors J. R. Arnold and W. F. Libby of the Institute for Nuclear Studies of the University of Chicago published a number of dates which they had obtained during the first eighteen months of their work with ancient organic material by testing the amount of Carbon 14, according to the process described above by Mr. Donald Collier. Certain of the results may be of interest.

In the spring of 1948 Professor Robert J. Braidwood conducted the first campaign of excavation at the site of Jarmo in northern Iraq. In a stratified area he found the first introduction of pottery immediately following pre-ceramic levels. This is the first time in the Near East that a cultural horizon has been found at the inception of village culture comparable to that at earliest Jericho in Palestine. Some land snail shells from the pre-ceramic levels were tested and found to be 6707 years old, with a margin of error computed at 320 years; that is, they are to be dated somewhere between 5077 and 4437 B. C. This gives us an approximate but reliable date for the first village culture and for the introduction of pottery. Heretofore, our dating for such early material has been largely guesswork.

When was the last glacial age? Several samples of wood and peat were tested which were recovered from the Two Creeks Forest Bed in Manitowoc Co., Wisconsin. Here a spruce forest is thought to have been buried by the last advancing ice sheet in this region. The average date of the samples came out at 9454 B. C., the margin of error being considered 350 years either way.

A confirmation of the general reliability of this method of dating came from three samples found in Egypt. One was a slab of wood from a beam in the tomb of a Vizier, named Hemaka, who lived during the First Dynasty. This Dynasty is generally dated today somewhere between 3100 and 2800 B. C. Two counting runs were made on the sample; the average date obtained was 2933 B. C. with a margin of error computed at 200 years. Among the earliest village cultures in Egypt are the remains excavated in the Faiyum. The date of a sample of wheat and barley grain from Faiyum A averaged about 4145 B. C. with a margin of error of 250 years. Excavations at el-Omari near Cairo have unearthed a culture which would appear to belong somewhere between the two mentioned above, judging from a typological comparison of the material. The testing of some charcoal from this site produced a date *ca.* 3306 B. C. with margin of error computed at 230 years. These three dates from early Egypt come out very nicely, since the material tested was from archaeolog-

ical contexts which can be arranged in a sequence, the latest of which is in the First Dynasty.

Fig. 4 on p. 7 shows the plan of a chapel unearthed at Tell Tainat (ancient Hattina) in northern Syria by the Oriental Institute in 1936. It has been dated to the eighth and seventh centuries B. C. Wood from the floor of a central room in the palace with which the chapel was associated was tested by three different counting runs. The first run produced a date at 746 B. C. with margin of error of 270 years; the second came to 698 B. C. with the same margin of error; the third to 289 B. C. with the same computed possibility of error. In other words, the first two runs produced dates which are certainly correct with the margin of error allowed. The date which came from the third run is strangely disconcerting, and seems difficult to believe even when the range of error is taken into account.

From the above sample dates it is clear that the Carbon 14 contribution to the problem of dating archaeological material is certain to be very great, especially in the earlier periods. At the moment, however, the margin of error which must be allowed is too great to be completely satisfactory for the historical periods, since it is often possible by various other means to fix the date more definitely. On the other hand, issues under sharp debate, such as that currently in process over the date of the Dead Sea Scrolls, can receive considerable help from the process. The date of the linen found in the cave, as determined by Professor Libby, certainly indicates that a medieval date for the cave material is out of the question, even though a more precise date than the process is able to give must be determined by other means.

G. E. W.